

**UNITED STATES OF AMERICA**  
**SPECIFICATION**

TO ALL WHOM IT MAY CONCERN BE IT KNOWN THAT:

**NIPUN GOPALDAS GUPTA**

has invented a certain **"AIR CONDITIONERS"**

of which the following is a specification

This invention relates to air conditioners and typically to air conditioners known as split air conditioners having an indoor unit and an outdoor unit cooperating with each other via ducting and piping.

A major concern in air conditioning system is the running cost and there is constant endeavor to conserve energy.

Air Conditioners can be broadly termed as devices which facilitate heat exchange from/to a closed environment/space.

Traditionally low tonnage systems are air-cooled and high tonnage systems are water-cooled.

The typical working of an air conditioner is as follows: An air conditioner has an evaporator unit and a condenser unit. In a split type air conditioner, typically the indoor unit houses the evaporator coils whereas the outdoor unit houses the condenser and the compressor. When an air conditioner is started high pressure & high temperature refrigerant is discharged from the compressor in the evaporator side . (Pressure=290 PSI & temp=90 deg). This refrigerant then passes through the typically copper tubes of the condenser coil of the condenser unit in the outdoor unit. Air is continuously blown over the condenser coil & generally finned aluminum surface bonded with the copper tubes. This cools down the refrigerant to typically 50 degrees Celsius & pressures typically at 270 PSI. The refrigerant then passes through capillary Tube (expansion device). When it comes out of capillary it expands & due to expansion there is sudden pressure drop, which also results in drop in temperature of the refrigerant. This low pressure, & low temperature

refrigerant flows through an evaporator coil located in a room or other environment which needs to be conditioned. A blower associated with the indoor unit sucks air from the environment in a room in which the air conditioner is installed & while passing over the evaporator coil the air cools down and is circulated back to the room environment thus the heat of the air is absorbed by the refrigerant & the cool air is circulated in the room. Because of the low temperature surface of evaporator coil, the moisture present in the air condenses on the evaporator coil surface & this moisture is drained out in the form of water droplets via a water drain attached to the evaporator coil in the indoor unit. Thus dehumidification process takes place. The refrigerant is then sucked by the compressor & this cycle continues.

In the case of low tonnage systems in split air conditioners a Reciprocating/ Rotary/scroll Compressor is used, typically where the Pressure of Suction and Discharge is in equilibrium at 75 psi [pounds per square inch] suction pressure and 300 psi discharge pressure.

For the Refrigerant R-22 the ideal performance is derived at 69/215 psi suction/discharge pressure which is not achievable in air cooled systems.

An object of this invention is to provide an air conditioning system which will give a suction pressure of 65 to 70 psi and discharge pressure of 210 – 225 psi.

Such a system if engineered would be more efficient than the traditional systems and also provide saving in energy consumption.

Another object of this invention is to provide an air conditioning system in which there is considerable power conservation.

According to this invention there is provided a split air conditioning system consisting of an indoor evaporator unit having a water drain extending from the evaporator coil and an outdoor condenser unit including a compressor and a condenser coil, characterized in that at least a portion of the water flowing through the said water drain of the said indoor unit is lead to the condenser coil of the outdoor unit for cooling of the condenser coil.

In accordance with one embodiment of the invention, the water from the water drain is sprinkled over the condenser coil.

In accordance with another embodiment of the invention, at least one spray nozzle is provided at or near the extremity of the water drain and the water is sprayed over the condenser coil.

In accordance with another embodiment of the invention, water from the water drain is lead to a tray at the base of the outdoor unit and a pump is provided to circulate water collected in the tray to at least one spray nozzle located in proximity to the condenser coil for spraying water on the condenser coil.

In accordance with another embodiment of the invention the base of the outdoor unit itself acts as a tray.

Typically, the one or more spray nozzles may be at a lower, upper or intermediate position with respect to the condenser coil. In accordance with one embodiment one of the members of the coil, typically the top most member is sealed off and perforated and water from the water drain or the pump is lead to the sealed element for spraying water on the condenser coil.

In accordance with a preferred embodiment of the invention, the base of the housing of the outdoor unit is formed to function as a tray for collecting water from the water drain of the indoor unit.

An auxiliary water source may be provided on line with the water drain arrangement in accordance with this invention. The water source may be provided in the spray for the condenser coil or may feed the tray element.

Control elements such as a flow meter or a level indicator may be provided to actuate the auxiliary water source in case of deficiency of water from the water drain or in the case of evaporation losses.

The objects of this invention are achieved in accordance with another aspect of this invention by using a hollow bodied coil, typically D or O shaped in the condenser unit and locating the fan approximately axially and at a location above or near the top of the coil.

In accordance with a practical embodiment of this invention the hollow bodied coil is used which is made with 3/8 inch single row tubes with 16FPI PCM Aluminum fins.

Operating the fan in suction mode will cause air to be sucked in through the base and the sides of the coil and the air dynamics follows a natural convention current path. In accordance with the system of this invention there is significant increase of air displaced through the condenser coils per unit time and there is also increased contact between the displaced air and the coils and fins.

In accordance with another aspect of this invention condensate water which is collected in the normal dehumidification process of the system by the evaporator is allowed to flow over the condenser unit of the split air conditioner at least once or is collected in a tray and caused to be circulated over the condenser coils of the condenser unit[ the outdoor unit] over several passes.

In accordance with this invention condensate water collected in a tray can be used for cooling the hot compressed fluid passing through the coils. This can be achieved in several methods. For instance a small pump can be installed which can draw water from the tray and lift it over the condenser coils for sprinkling. The water after sprinkling falls back into the tray. The condensate water which is at temperature lower than the ambient causes immediate drop in the temperature of the refrigerant fluid in the coils. Another method of using the condensate water is to dip one or more coils of the condenser into the water borne in the tray.

The cooling of the condenser using waste condensate water can be in addition to or an adjuvant to air cooling.

Typically, water is made to fill in the base tray upto the first to hair pin bends of the coils.

Thus in accordance with this invention waste water is circulated over the condenser coil surface, which additionally cools the refrigerant, & the pressure is dropped to 220 PSI. This refrigerant then passes through capillary Tube (expansion device). When it comes out capillary it expands & due to expansion there is sudden pressure drop, which also, results in drop in temperature of the refrigerant. This low pressure & low temperature refrigerant flows through evaporator coils.

Due to additional pressure & temp drop by the additional cooling by the water circulation. The condenser pressure is reduced which results in increase in refrigeration effect & volumetric efficiency. The power consumption is reduced due to reduced mass flow (due to increased refrigeration effect & & reduction in specific work due to reduced pressure ratio).

The water, which is used for circulating over the condenser coils, is the condensate water generated due to dehumidification process in the indoor unit i.e. the evaporator.

The water consumption depends on temperature as the temperature increases the water consumption is more due to more evaporation.

In dry areas where the humidity is less & the temperature is more it is envisaged that an external water source via a solenoid valve & the water level controller, which will maintain the water level in the tray.

The invention will now be described with reference to the accompanying drawings, in which

Figure 1 is a general lay out of a conventional split air conditioning system;

Figure 2 is a lay out of the split air conditioning system in accordance with this invention;

Figure 3 is an alternative embodiment of the split air conditioning system in accordance with this invention;

Figure 4 is another embodiment of the split air conditioning system in accordance with this invention wherein a water tray is provided at the base of the outdoor unit; and

Figure 5 is another alternative embodiment of the split air conditioning system in accordance with this invention in which an auxiliary water drain is provided in the water drain.

Figure 6 is another alternative embodiment in which water collected at the base of the outdoor unit is sprayed from near the water level on the condenser coil and an overflow drain is provided for draining excess water from the base of the condenser unit.

Figure 7 is a plan view of the split air conditioning system in accordance with this invention

Figure 8 shows Table 1 which consists of test results of 7 conventional split air conditioners at 35 degrees Celsius ambient without spraying of water from the indoor unit on the condenser coil;



Figure 9 shows Table 2 which consists of test results of 7 conventional split air conditioners at 35 degrees Celsius ambient with spraying of water from the indoor unit on the condenser coil;

Figure 10 shows Table 4 which consists of test results of 7 split air conditioners in accordance with this invention with an O type condenser coil but without spraying water from the indoor unit on the condenser coil;

Figure 11 shows Table 3 which consists of test results of 7 split air conditioners in accordance with this invention with an O type condenser coil with spraying water from the indoor unit on the condenser coil.

Referring to the drawings, a split air conditioning unit is generally indicated by the reference numeral 10. The split air conditioning system 10 consists of an indoor evaporator unit 12 having a water drain 14 extending from the evaporator coil [not shown] and an outdoor unit 16 including a compressor [not shown] and a condenser coil 18. The outdoor unit also includes a fan 20. In the operative configuration of the fan 20, air is sucked in through the coil 18 which cools the refrigerant passing through the coil. Refrigerant in fluid form flows via conduits 21 between the indoor unit 12 and the outdoor unit 16.

The split air conditioning system 100 according to this invention is illustrated in figures 2 to 6 in which the water from the water drain 114 is sprinkled over the condenser coil 118.

As seen in figure 2 the condenser unit 118 can be a conventional rectangular bodied condenser or as seen in figures 3 to 6 can be a D or O shaped hollow

bodied coil and the fan 120 can be located roughly axially above or near the top of the coil 118. A plan of the arrangement seen in figures 3 to 6 is seen in figure 7.

At least one spray nozzle/pipe [122,123] is provided at or near the extremity of the water drain 114 and the water collected in the dehumidification process in the indoor unit 112 is sprayed/sprinkled over the condenser coil 118 of the outdoor unit 116 by means of the spray nozzle/pipe 122,123. Refrigerant in fluid form flows via conduits 121 between the indoor unit 112 and the outdoor unit 116.

In one embodiment of the invention a tray 124 [ as seen in figures 4,5 and 6] is provided at the base of the outdoor unit 116 and water from the water drain 112 is lead to the said tray 124 and a pump 126 is provided to circulate water collected in the tray 124 via a conduit means 136 to at least one nozzle/pipe [122,123] located in proximity to the condenser coil 118 for spraying/sprinkling water on the condenser coil 118. The tray 124 can be attached to or formed in the base of the outdoor unit 116. The one or more nozzles/pipes [122,123] can be at a lower [figure 6], upper or intermediate position with respect to the condenser coil 114.

Alternatively at least one of the turns[ not shown] of the coil 114, typically the top most turn is sealed off and perforated and water from the water drain or the pump is lead to the sealed element for spraying water on the condenser coil. The sealed portion thus acts as a spraying nozzle.

In the embodiment seen in figure 5, an auxiliary water source 128 is provided on line with the water drain 112 arrangement in accordance with this invention. As seen in figure 5, control elements such as a feed control valve 130 and/or a level indicator 132 may be provided to actuate the auxiliary water source in case of deficiency of water from the water drain or in the case of evaporation losses. The lower turn/turns of the coil [not shown] can be made to dip in the tray 124 for additional cooling. An overflow drain 134 can be provided to the tray 124 for draining excess of water collected in the tray 124.

A different spraying arrangement is seen in figure 6, in which the conduit 136 from the pump 126 is terminated at the bottom of the coil 118 and water is sprinkled operatively upwards on the condenser coil 118. After sprinkling water again collects in the tray 124. Excess water in the tray is drained out through overflow drain 124.

Figure 7 is a plan view of the arrangement seen in figure 6.

The water may be sprinkled in different ways as follows:

1. The drain pipe coming from Indoor unit is connected directly to a perforated pipe which is fitted over the condenser coil .The water thus drops over the condenser coil & is circulated over the surface of condenser coil & helps in cooling the condenser coil. This water is then collected in the water tray provided below the condenser coil & re-circulated by using a water pump.
2. The drainpipe coming from Indoor unit is connected to inlet tube of the water tray. Water is collected in the tray water is then lifted by a

water pump .The outlet of the pump is connected to the perforated pipe which is fitted over the condenser coil. The water thus drops over the condenser coil & is circulated over the surface of condenser coil & helps in cooling the condenser coil. This water is then collected back in the water tray provided below the condenser coil.

3. The drainpipe coming from indoor unit is connected to inlet tube of the water tray. Water is collected in the tray water is then lifted by a water pump. The outlet of the pump is connected to the perforated pipe, which is fitted at the base of condenser coil. Due to pressure generated by the pump the water rises like water fountain in the gardens & this water then drops over the condenser coil & is circulated over the surface of condenser coil & helped in cooling the condenser coil. This water is then collected back in the water tray provided below the condenser coil.
4. The drainpipe coming from indoor unit is connected to inlet tube of the water tray. Water is collected in the tray. Water is then lifted by a water pump in a vertical pipe to which jets are fitted. The water comes out of jet in sprinkle form & is sprayed over condenser coil & is circulated over the surface of condenser coil & helps in cooling the condenser coil. This water is then collected back in the water tray provided below the condenser coil.
5. The water collected in the tray may be sprayed over condenser coil just like the sprinkler system used for agricultural purpose.

6. In accordance with one aspect of the invention the base pan unit of the condenser coil can be designed such that it will collect water into it & circulate and functions as a tray.
7. The water may be circulated on the top row copper tube of condenser coil, which will be made perforated.
8. Due to the collection of heat from the condenser coil the water gets heated up. For this purpose a coolant can be mixed with water, which will help to keep the water temperature low.
9. The heat exchanger coil may be of different shape like: O, S, D, U, Square, and Rectangular and the like.
10. For cooling of water a system like small cooling tower can also be used.
11. This concept can also be implemented in window air conditioners.

The results obtainable from using the features of this invention at conditions of 35 degrees Celsius ambient are typically as under :

1. SUCTION PRESSURE 65PSI
2. DISCHARGE PRESSURE 240 PSI
3. COMPRESSOR CURRENT 6.5 A AGAINST STD 9.5 A
4. TOTAL CURRENT OF SYSTEM 8A
5. TOTAL SYSTEM WATTAGE 1650 AGAINST 1950 STD

## 6. TRIP RATIO( COMPRESSOR ON TIME 55% AGAINST 60% STD

### Experiments:

7 split air conditioners having rectangular solid body condenser coils and 7 units having a hollow bodied O shaped condenser coil were selected for experimentation and testing. All 14 air conditioners were tested for 35 degrees ambient air conditioning. Tests were conducted in normal running when water from the indoor unit was drained out and in the method of this invention when the water from the water drain of the indoor unit was led to the outdoor unit and sprayed on the condenser coil. The test results were tabulated in Tables 1 to 4 seen in figures 8 to 11 of the accompanying drawings. In the Tables, W.B. and D.B. stand for the wet bulb and dry bulb temperature of a Wet and Dry bulb thermometer.

During the dehumidification the amount of water collection for a 1.5 ton split air conditioner is as follows:

Moisture removal rate: 2.9 ltr/Hr at rated conditions (for moisture removal rate the specified rated conditions are:

Indoor Side: Dry Bulb temp = 27 deg C

Wet Bulb Temp = 24 deg C

Outdoor Side: Dry Bulb temp = 27 deg C

Wet Bulb Temp = 24 deg C

The water consumption in the outdoor unit is as follows:

1. At 46 deg C ambient, water consumption is 2.7 ltr/hr
2. At 35 deg C ambient, water consumption is 700 ml/hr

1. The tables show that the system of this invention delivers significantly improved cooling and an accelerated cooling rate and a capacity of 100% of 18000 BTU + PLUS
2. The system of this invention saves over 20% in power consumption.

While the present invention has been described herein with reference to a specific embodiment thereof, it is contemplated that the present invention is not limited thereby and various changes and modifications may be made therein for those skilled in the art without departing from the scope of the invention. For instance, further improvements are possible by varying capillary length and bore and providing an accumulator to the liquid line which is typically dipped in the condensate water bearing tray and be reducing evaporational losses from the tray.